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Contesting the termite hypothesis for the origins of heuweltjies in Clanwilliam, South Africa

The hunting of the Snark

They sought it with thimbles, they sought it with care;
They pursued it with forks and hope;
They threatened its life with a railway-share;
They charmed it with smiles and soap.

They hunted till darkness came on, but they found
Not a button, or feather, or mark,
By which they could tell that they stood on the ground
Where the Baker had met with the Snark.

In the midst of the word he was trying to say,
In the midst of his laughter and glee,
He had softly and suddenly vanished away —
For the Snark *was* a Boojum, you see.

-The Hunting of the Snark by Lewis Carrol

Abstract

The age and origins of large earth mounds (locally termed "heuweltjies") is under debate, with ages being proposed for between 4500 and 30 000 years old, and hypotheses including zoogenic and geological origins of the mounds. The widely accepted hypothesis for the origins of the heuweltjies found in the South Western Cape of South Africa is that mounds are ancient termitaria, belonging to the southern harvester termite *Microhodotermes viator*. Our idea was to use rocks and stone layer profiles to determine approximate ages of the heuweltjies as well as to gather evidence to either support or refute the termite hypothesis. We excavated ten mounds in Clanwilliam, South Africa, to gather stone and rock profiles throughout the mounds, as well as digging a trench through a heuweltjie with bedrock as its matrix in order to determine the extent of the bedrock into the mound. No stone layers as such were found. What we did find was that the mounds are a whole order of magnitude greater in volume than large termite mounds made by the northern harvester termite *Macrotermes* in tropical regions, and many of the mounds contain large rocks both throughout the mound as well as on the surface. The trench cut through the mound on bedrock revealed the bedrock extending all the way to the centre of the mound, on the same level as the surface of the surrounding matrix. This evidence can be used to refute the termite hypothesis for the heuweltjies of Clanwilliam as it is virtually impossible for termites to move rocks up to 25 kg to the top of a mound, and mining soil from beneath a mound with bedrock at its base is an impossibility.

Introduction

The origins of earth mounds are controversial and contested worldwide (Moore & Picker 1991) and arguments on the topic date back as far as the mid nineteenth century (Aten & Bollich 1981). Mounds are a common feature in landscapes throughout the world (Silva et al. 2010), including regions of the Neotropics (McCarthy et al. 1998, Cox 1984), Australia (Brockwell 2006), both North (Ross et al. 1968) and South (Silva et al. 2010) America (Moore & Picker 1991) and in both eastern and southern Africa (Moore & Picker 1991, Midgley et al. 2002, Picker et al. 2007, Potts et al. 2009) though mounds in different areas are possibly of different origins (Silva et al. 2010). Heuweltjies (often referred to as mima-type mounds, but here referred to by their local Afrikaans name 'heuweltjie' meaning small hill) occur throughout many landcapes in the South Western Cape of South Africa (Midgley et al. 2002), occupying up to 14-25 % of the land surface (Moore & Picker 1991). They are mounds of earth reaching approximately 20-30 m in diameter and 0.3-2 m in height (Moore & Picker 1991; Midgley et al. 2002). They have a variable density of between 143 and 704 per km^2 (Picker et al. 2007). There is some debate as to the age of the heuweltjies in the South Western Cape, with reports of formation ranging from ~*ca.* 4 500 (Moore & Picker 1991) to ~*ca.* 30 000 (Midgley et al. 2002) years before present (BP). The debate on the origins of heuweltjies is unresolved, with considerable evidence being cited in support for a zoogenic origin, while other hypotheses include geological origins (Moore &Picker 1991, Potts et al. 2009) and mole rat bioturbation (Lovegrove & Siegfried 1986), though these have mostly been refuted. It is now popularly accepted that heuweltjies are the result of occupation of the southern harvester termite *Microhodotermes viator* (Midgley et al. 2002, Picker et al. 2007, Potts et al. 2009).

There are five major hypotheses proposed for the formation of such earth mounds worldwide (Cox 1984). The frost-sorting hypothesis envisages the mounds formed by the same processes operating in arctic and alpine regions to form stone nets and frost boils (Cox 1984). The erosion hypothesis sees the mounds an mound-fields as part of fossil landscapes formed under dry previous climates, whereby wind erosion, surface water erosion or internal drainage has removed intermound material, leaving raised mounds (Cox 1984). The wind deposition hypothesis or bush-clumps hypothesis postulated Aeolian deposition of material around large plants or clumps of plants during dry past climates (Cox 1984). The fossorial rodent hypothesis suggests mound formation by build up of soil displaced by tunnelling fossorial rodents such as pocket gophers (Cox & Gakahu 1984). Finally, the termite hypothesis proposes mounds to be ancient and/or fossilised termite mounds dating back either 4500 or 30 000 years ago .It is this hypothesis that has been proposed for the origin of the heuweltjies in the South Western Cape, and it has received widespread acknowledgment and is supported by both evidence and opinion (Moore & Picker 1991, Midgley et al. 2002, Picker et al. 2007, Potts et al. 2009).

Picker et al. (2007) found a significant positive relationship between heuweltjie density and rainfall in areas of high fertility soil and <350 mm rainfall, indicating an equilibrium between *M. viator* and current climatic conditions, indicating construction of the mounds by their current occupants. Further evidence was presented by Moore & Picker (1991), who show that nearly all mounds present today are occupied by *M. viator*, and many of the mounds contain fossilised *M. viator* tunnels. Also, the presence of the calcrete layer beneath the mounds is analogous to that found beneath termite mounds (Moore & Picker 1991). Intermound distance between the heuweltjies in Calnwilliam is not dissimilar to that of *M. viator* nests found in the central Karoo (Moore & Picker 1991), indicating further support for the termite hypothesis for their origins. Maduakor et al. (1995) report *Macrotermes* mounds in Nigeria to show no enrichment in on mound soil nutrients in comparison to the surrounding matrix (Brossard et al. 2007). However, this is refuted by Fleming & Loveridge (2003) who found *Macrotermes* mounds in Zimbabwe supporting vegetation entirely different to that of the surrounding woodland vegetation. This was due to the mounds having a substantial effect on the soil nutrient composition, with on mound soils showing greater nutrient, pH and soil moisture contents than the surrounding matrix (Lee & Wood 1971, Fleming & Loveridge 2003). A similar tendency was found in the heuweltjies in Clanwilliam, which were shown to have significantly higher nutrient concentrations (Ca, Mg, K, P, Mn and N) than the surrounding intermound areas (Midgley & Musil 1990). Termite mounds tend to be dominated by fine material when they occur in areas of coarse sands (Lee & Wood 1971) due to size limitations on particles termites are able to transport (Moore & Picker 1991). A similar trend was shown for the heuweltjies in Clanwilliam, with gravel and pebble sized rocks found rarely on mound surfaces, but abundant in intermound areas (Cox et al. 1987, Moore & Picker 1991), though no quantitative data were collected on particle size. The presence of a calcrete layer beneath the mound is common in both termite mounds (Potts et al. 2009) as well as in heuweltjies (Moore & Picker 1991, Midgley et al. 2002, Potts et al. 2009).

This project centres on determining the origin and age of heuweltjies and I hypothesise that I will find conclusive evidence to refute the termite hypothesis for the origins of the heuweltjies found in Calnwilliam. I have used various approaches to do this. Firstly, I asked whether the position of the stone layer found within the heuweltjies could be used to interpret the age of the mounds, depending on whether the layer was lowered, level or raised within the mound in comparison to the surface of the matrix. The logic is that a lowered stone layer within mounds is indicative of bioturbation as removal of material from below the stones would cause them to sink. A stone layer within the mound lying at the same level as the surface of the matrix would indicate mounds being the result of deposition, most probably aeolian, on the original surface. Finally, a raised stone layer within the mound would indicate erosion of the original surface with lowering of the stone layer of the matrix, while that in the mounds remains at the original level. My second question was whether the presence and density of stones and rocks in, on and around the heuweltjies could be used to determine whether they are erosional or depositional features within the landscape, in order to take a step closer to determining their origins definitively. The logic in this follows that if there are no stones present in the mounds they are either a product of deposition or bioturbation, but if stones and/or rocks are present in and/or on the mounds the probability of bioturbation is very low and they are most likely a product of erosional forces. In order to do this we excavated both heuweltjies and the surrounding matrix so as to compare the soil and stone profiles of each, as well as to take samples for soil particle analyses and get an idea of stone densities. I also analysed the morphometrics of mounds in relation to slope in order to determine correlations to erosion coefficients determined for the area in which the heuweltjies occur.

Materials and Methods

Study Site

The study site is located near the town of Clanwilliam, approximately 250 km north north west of Cape Town (Fig. 1) at 32°11'00.24"S 18°54'00.14"E. The site itself was on the south western banks of the Clanwilliam dam between 5 and 40 m above the high water mark (Fig. 2). The area lies within a winter rainfall area and falls within the Succulent Karoo biome (Mucina & Rutherford 2006), with Clanwilliam Karroid shrubland as the dominant vegetation type (Campbell 1985). Annual maximum temperatures reach up to 26°C (monthly average) over December, January and February, while minimum temperatures are between 7° and 9°C between May and September. Heuweltjies occur mainly in areas of renosterveld and succulent karoo vegetation, although are not restricted to these and occur in some fynbos regions too, though not in true fynbos (Mucina & Rutherford 2006). They are particularly prominent in winter rainfall areas (Mucina & Rutherford 2006) and a significant relationship was found between mound density and rainfall in areas of <350 mm of rainfall per year and high fertility soils (Picker et al. 2007), though these were never for sandstone soils, in which no relationship was fund.

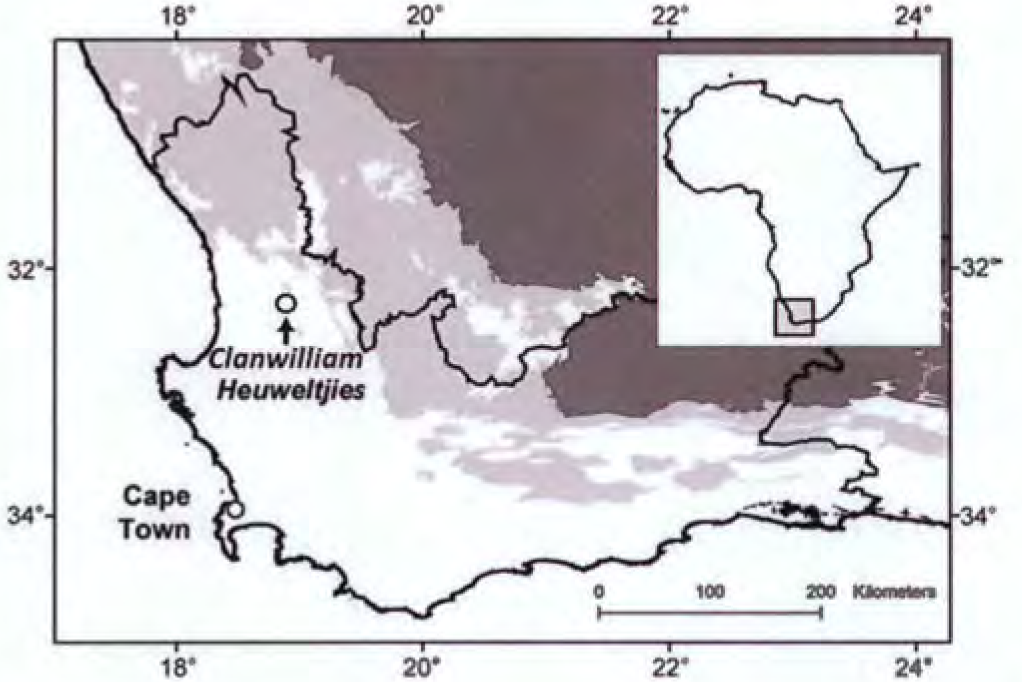


Figure 1. Map of the Western Cape, South Africa (Africa in inset) showing the location of the study area in Clanwilliam. Adapted from Potts et al. (2009).

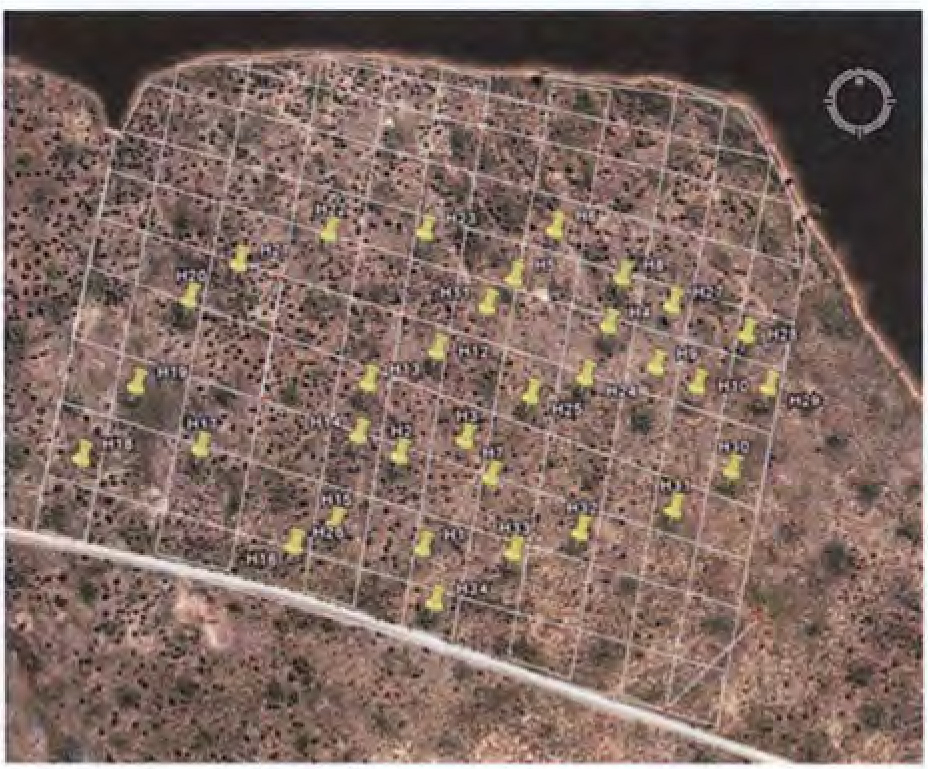


Figure 2. Aerial photographic view of sampled heuweltjies. H1 to H10 were excavated, H11 to H34 were measured for down- and cross-slope length and height. H4, H7, H8, H24 & H25 were measured in detail for profile plots. Grid plotted to determine point elevations and distances in order to calculate slope and plot the surface (Fig. 9). Image from Google™ Earth (Google ™).

Sampling Protocol

Thirty four heuweltjies were sampled for down-slope and cross-slope length, height and slope measurements. Stakes were placed upright off mound on either side of the heuweltjie (both down- and cross-slope) with a line stretched tautly between them and supported in the middle to correct for sag. The distance between the stakes was measured and the height above the soil surface measured at the stakes. The number of rocks on the soil surface was recorded as well as the size classes (kg) of those rocks. The surroundings were examined for type of matrix (sandy or bedrock) as well as the number of loose rocks found within the matrix (scored as 'few' or 'many').

Five heuweltjies were measured in greater detail for down- and cross-slope height profiles, with height above soil surface measured across the heuweltjie at 1 m intervals on both axes. This data was used to obtain a shape profile for these heuweltjies.

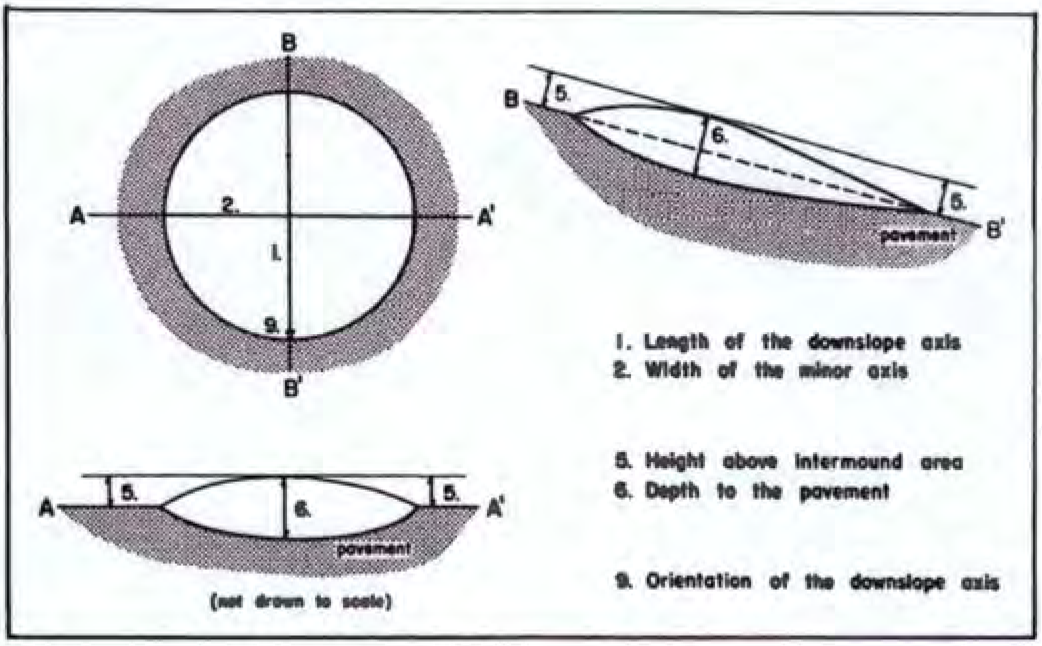


Figure 3. Down- and cross-slope measurements taken from 34 heuweltjies in Clanwilliam. Adapted from Vitek (1978)

Down- and cross-slope lengths were used in conjunction with heights in order to calculate the volume of each heuweltjie using the following equation:

$$V = (\pi r^2)^* H_{av}$$

Where r is the radius of the heuweltjie and H_{av} is the average height across the heuweltjie. A paired t-test was performed using Microsoft Excel (version 2007) on the down- and cross-slope data to check for significant differences in length between down- and cross-slope measurements. The recorded rock data was separated into both number and size classes and plotted as the percentage of the number of measured heuweltjies showing those rock characteristics. Data on the surroundings (sandy, bedrock, amount of loose rock) were also plotted as the percentage of measured heuweltjies with each surrounding class and number of loose rocks in the matrix. The profile data from the five heuweltjies measured in detail was used to construct plots showing down- and cross-slope length measurements on the same axis.

Ten of the heweltjies were excavated. Pits were excavated in the centre of each heuweltjie down to bedrock, or if the rock layer was very deep the maximum depth dug to was 1.5 m below the heuweltjie surface. The depths at which rocks, the calcrete layer surface and thickness and termite activity occurred within the soil profile were noted and soil samples were taken at 25 cm depth intervals for further analysis. Additional holes were dug upslope in the surrounding matrix from eight of the ten mounds and samples were taken from these in the same manner. In one heuweltjie (H8) a trench was dug down to the bedrock from the perimeter into the centre of the heuweltjie and samples were collected in the same manner as for the pits, but were taken at 1 m intervals from the perimeter into the centre, in order to obtain soil particle profiles not only with depth but also with proximity to the centre of the heuweltjie.

Soil Analysis

Soil samples from the 10 excavated heuweltjies were sieved through a 2 mm mesh sieve to separate coarse particle soil from stones and organic matter. Using an

Endecotts test sieve shaker, each sample was sieved for three minutes and then matter <2 mm and >2 mm was weighed to determine percentage composition. Fifty grams of each <2 mm sample were weighed out and soil particle analyses using the Boyoucous Hydrometer method (Boyoucous 1956) were performed in order to obtain fine particle size distribution with depth throughout each sampled heuweltjie. Samples were sieved through a 2mm mesh sieve for three minutes to exclude stones, organic matter and large particles from the experiment. 50 g of each sample was weighed out and masses were recorded. Each 50 g sample was mixed with 100 ml sodium hexametaphosphate and ~400 ml de-ionised water in a beaker and blended for approximately 30 s using a standard kitchen blender to break up any leftover conglomerates. Each mixture was then poured into its own 1000 ml measuring cylinder and the beaker was rinsed to ensure all particles were included. The mixture in the cylinder was then topped up to 1000 ml with de-ionised water. The opening of each cylinder was completely covered and the cylinders were inverted to mix the solution and make sure all particles were in suspension at time zero. Once the cylinder was turned upright the timer was started and the hydrometer was inserted into the cylinder. After 40 s the first reading on the hydrometer was taken, as well as the temperature of each mixture. The final reading for each cylinder was taken two hours after time zero and the temperature was taken again. Changes in temperature were noted and each reading was adjusted for temperature by adding 0.4 for each degree above 20°C and subtracting 0.4 for every degree below 20°C. The hydrometer measures density in $g.L^{-1}$ and the following calculations were used to obtain % sand, clay and silt respectively:

$$\% \text{ Sand} = \frac{\text{Sample weight} - \text{Reading at 40 s}}{\text{Sample weight}} \times 10$$

$$\% \text{ Clay} = \frac{\text{Reading at 2 hrs}}{\text{Sample weight}} \times 100$$

$$\% \text{ Silt} = 100 - (\% \text{ Sand} + \% \text{ Clay})$$

Percent Clay, silt and sand readings were obtained from the hydrometer readings and this data was then used to construct soil profiles with depth averaged across all ten of the excavated heuweltjies, both on mound and off mound. In order to determine significant differences between the average percentages of each particle size both on and off the mounds Kruskall-Wallis Multiple Comparisons analyses were performed using STATISTICA (Version 9.0, Statsoft, Inc.) on the % sand, silt and clay data. Paired t-tests were then performed to determine differences between on and off mound percentages of each particle size separately.

Analysis of variation in heuweltjie size with landscape slope

Heuweltjie positions were plotted in Google™ Earth (accessed October 2010, Google™). A grid was superimposed on the study site with squares approximately 50 m^2 in size (Fig. 2). Distances between each point and altitudes at each XY point were used to construct a 3D surface plot of the study area (Fig. 9) using Power-surface (v1.5, R Kalita, Eastern star software, Guwahati, India). The elevations of the area 50 m in all directions from the heuweltjie (1 m resolution) were calculated from the surface equation (4th order). The following equation was used to then estimate a slope-based erosion coefficient (S_i):

$$S_i = -1.5 + \frac{17}{(1 + e^{(2.3 - 6.1 * \sin\theta_i)})}$$

(Nearing 1997, Cohen et al. 2005)

Where θ is the slope angle of cell *i* (Cohen et al. 2005). These values were then plotted against heuweltjie volume and height to determine relationships between the variables. For the erosion coefficient vs height plot, two distinct groups were seen. A t-test was performed to check for significant differences in height between the two groups, and a simple regression was performed on slope vs heuweltjie height in order to determine whether slope has an influence on heuweltjie height.

Results

Heuweltjie shape characteristics

Table 1. Heuweltjie shape characteristics averaged across all heuweltjies measured. T-test value indicates significant difference between down-slope and cross-slope length measurements.

	Down-slope* (D) m	Cross-slope* (C) m	Eccentricity D/C	Area m^2	Max height m	Volume m^3
Average	22.8	21.5	1.1	2571	0.9	234
SE	0.7	0.7		281	0.1	16
Min	12.6	13.6		609	0.4	125
Max	31.0	29.0		7466	1.7	511
T-test	P = 0.005					

*indicates variables used in paired T-test

Down-slope lengths are significantly greater than cross-slope lengths ($p = 0.005$) by an average of 4.9 %, with an eccentricity factor of 1.1 (Table 1). Down-slope and cross-slope length measurements for five heuweltjies illustrate the variability between down- and cross-slope shape on each heuweltjie, as well as the variability in size and shape between the heuweltjies (Fig. 4). Excavated heuweltjies all showed similar visual patterns with depth regarding soil composition of layers. The general pattern was a loose sandy surface layer, followed by a harder, more compacted clayey layer below. Below this was the calcrete layer (if present) which extends down into each heuweltjie, with calcrete reaching varying thicknesses ranging from *ca.* 5 to *ca.* 70 cm (personal observation). Below the calcrete was another compacted clayey layer which extended to the bedrock. Where termite activity was present it occurred in the compacted clayey layers, either above or below the calcrete, with occasional tunnels found within the calcrete, though the clacrete tunnels were not found with termites in them or frass, indicating no current termite activity within the calcrete.

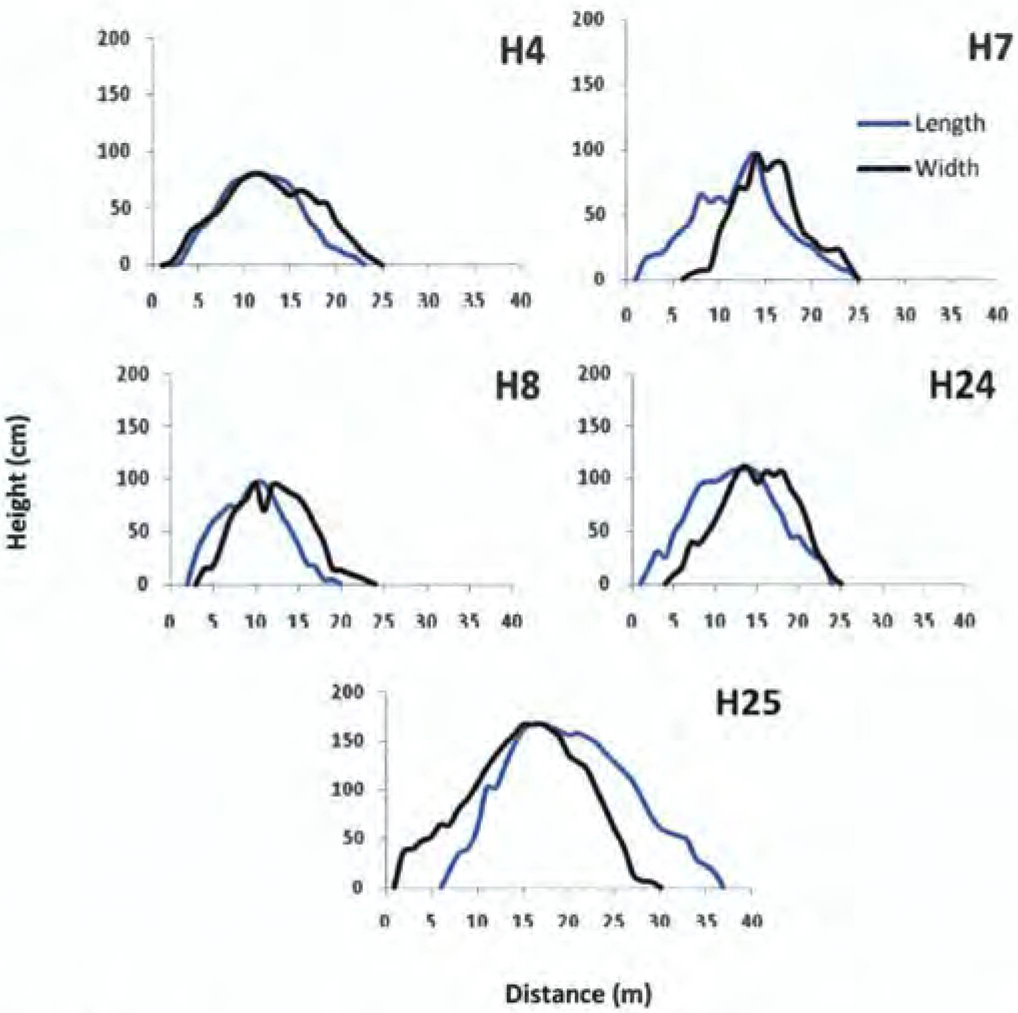
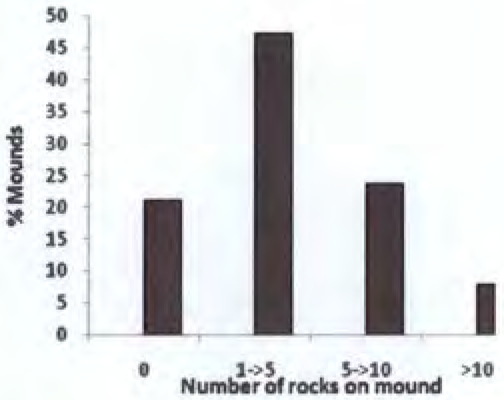


Figure 4. Down- and cross-slope length measurement profiles of five measured heuweltjies.

Heuweltjie Rock characteristics

Forty seven percent of the heuweltjies had between one and five rocks on the surface and 43 % of the rocks found on heuweltjie surfaces were in the <2 kg category (Fig. 5). Fifty nine percent of the mounds had bedrock as the surrounding matrix, while 41 % were found in sandy surroundings (Fig. 6). Thirty eight percent of the heuweltjies found within a sandy matrix had few rocks in the surrounds, while only 6 % showed many rocks in the surrounds (Fig. 6). Those found in a bedrock matrix showed the same pattern in that fewer heuweltjies (21 %) had many rocks in the surroundings, while more (44 %) showed only few rocks (Fig. 6).



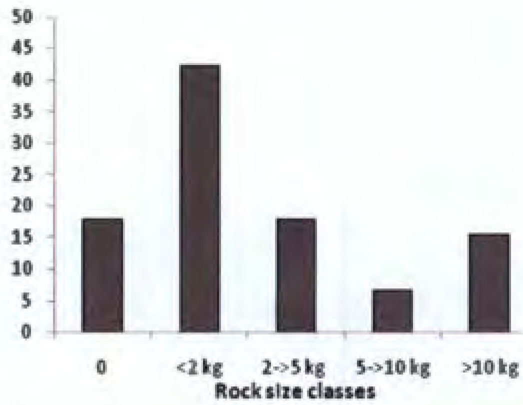


Figure 5. The percentage of measured heuweltjies with surface rocks as well as the size classes of the rocks found and the percentage of measured heuweltjies with rocks from each size class.

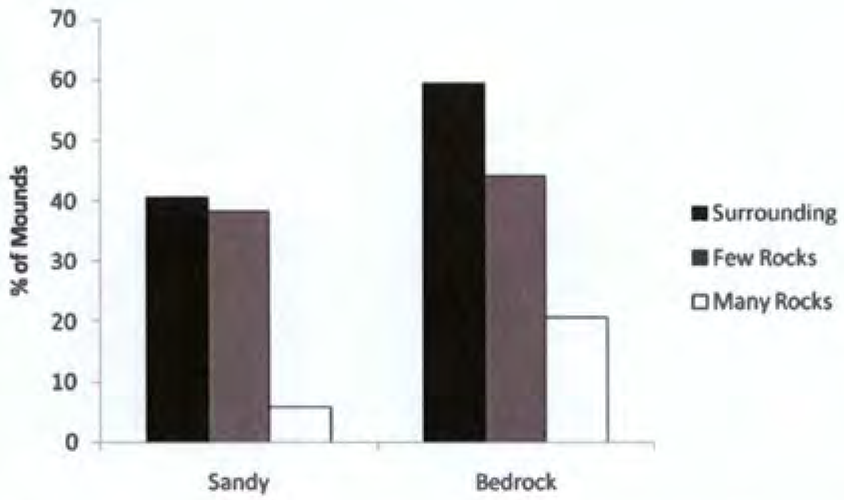


Figure 6. The percentages of mounds with sandy or bedrock surrounds, as well as the percentages of mounds with few or many loose rocks within those surrounds.

Heuweltjie soil characteristics

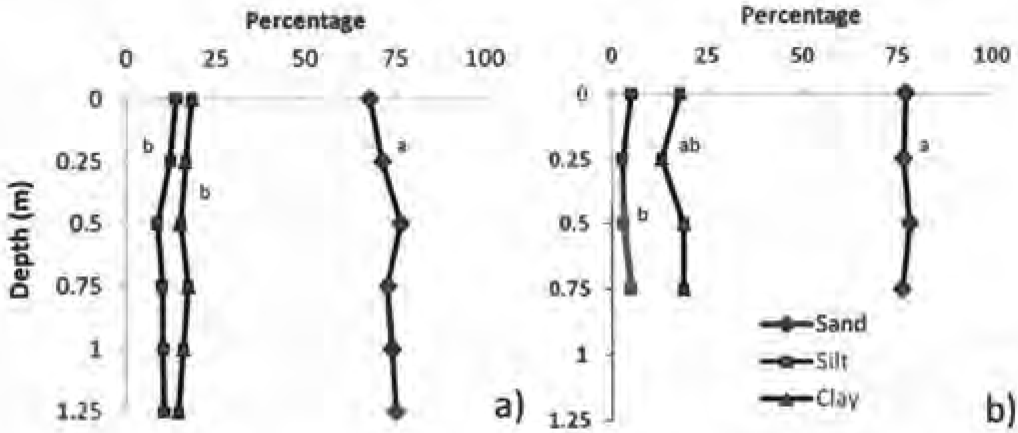


Figure 7. Average percentages of sand, clay and silt (± SE) found at different depths both a) on and b) off the mounds. Letters corresponding to each progression line indicate significant differences between percentages of particles.

Most notable about the progression of soil particle composition with depth for both on and off mound measurements averaged across the ten excavated heuweltjies (Fig. 7) is the fact that there is no significant change in total soil composition with depth for both on and off mound samples. However, off mound surface samples to had significantly more sand than on mound surface samples (paired t-test: $p = 0.000$), while the opposite was true for silt and the off mound surface samples had significantly less (paired t-test: $p = 0.000$). Clay showed no significant difference. On mound % sand is significantly different to % silt (t-test: $p = 0.000$) as well as % clay ($p = 0.039$), while % silt and % clay are statistically similar. Off mound % sand is statistically different to % silt (t-test: $p = 0.000$), but not to % clay, which is statistically similar to both. Surface composition of particle sizes showed no significant change with proximity to the centre of the mound (Fig. 8), though there was a slight increase in % silt with proximity to the centre of the mound, coupled with a slight decrease in % sand. The decrease in sand and increase in silt with proximity to the mound agrees with the results of the paired t-tests between on and off mound surface samples. Percent Clay remained relatively constant. At 25 cm depth throughout the heuweltjie there was a slight decrease in % clay coupled with a slight increase in % silt, though neither is significant; and at 50 cm depth we see very little change in soil composition with proximity to the centre of the mound.

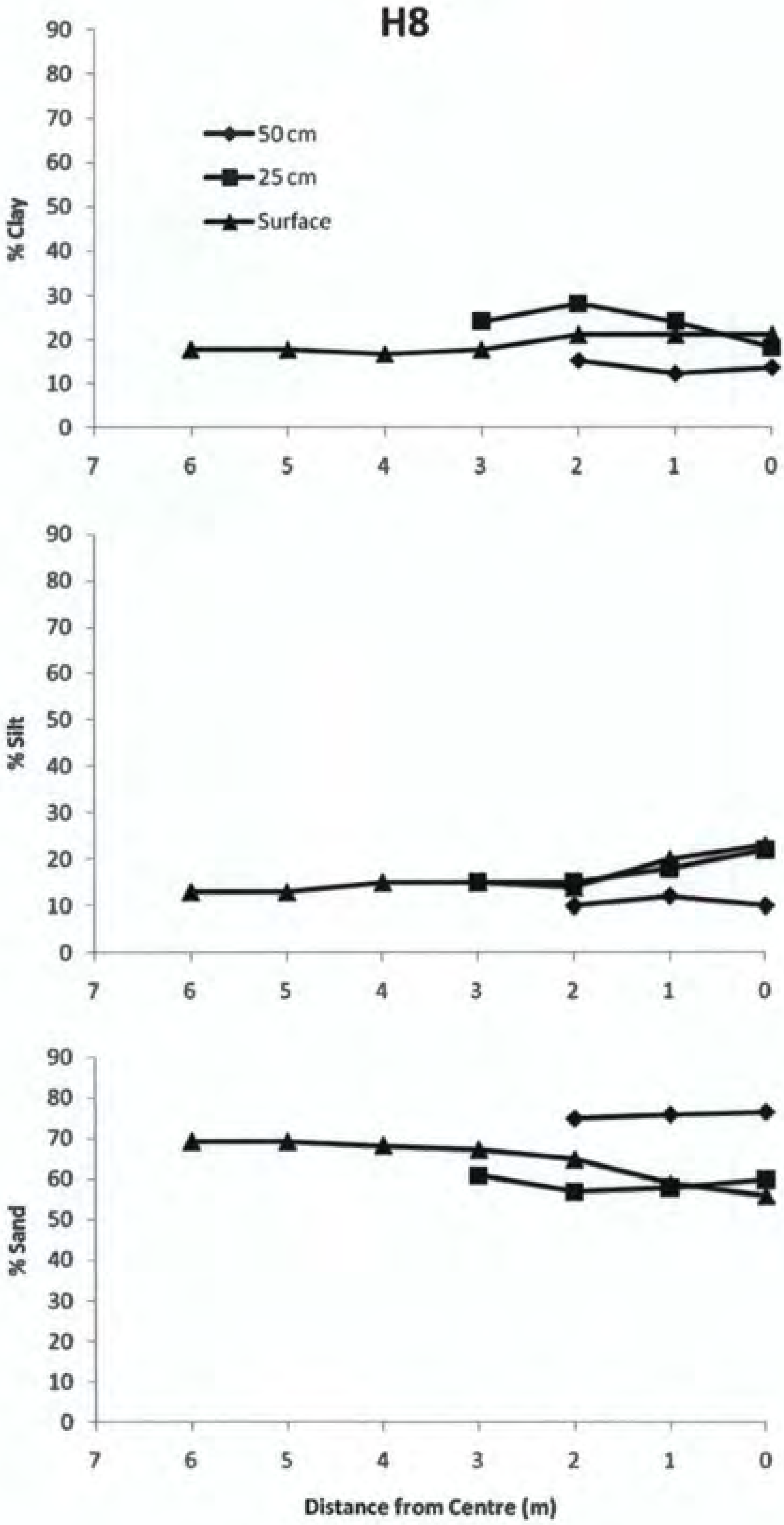


Figure 8. Percentages of sand, silt and clay found in heuweltjie 8 (H8) plotted against proximity to the centre of the mound.

Heuwelţjie landscape profile

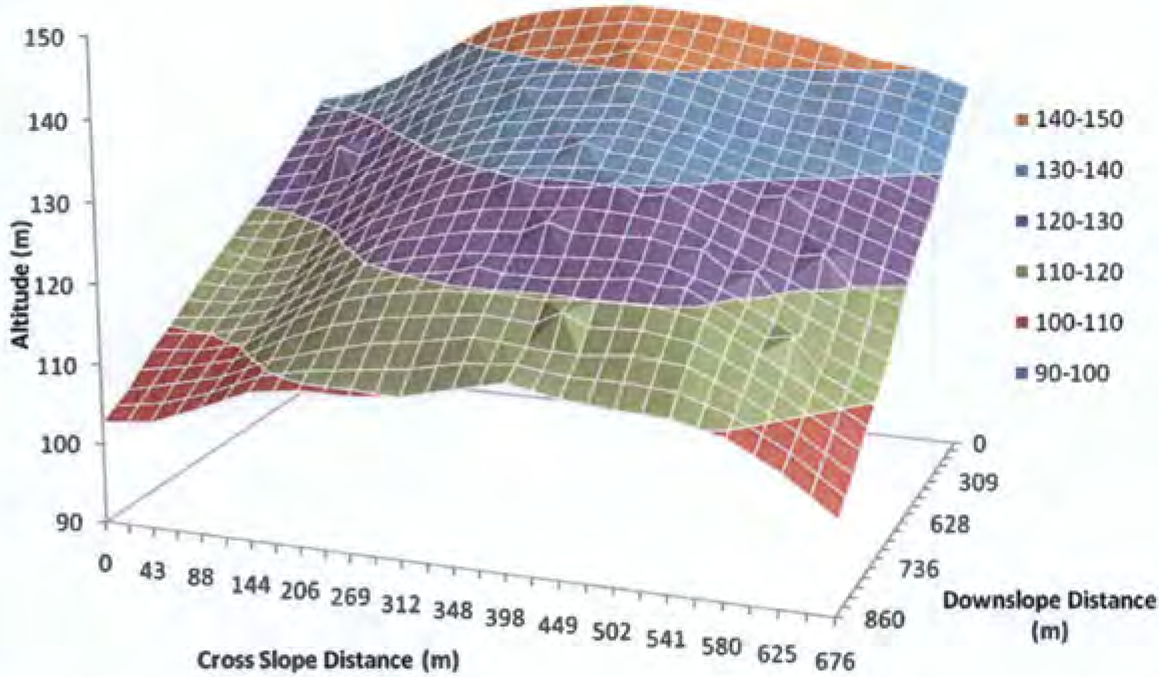


Figure 9. Positions of measured heuweltjies within the study area (Excel). Down- and cross-slope distance and altitude of the study area measured as points and distances of the grid shown in fig. 2.

The basic profile of the study site indicates the heuweltjie positions as well as slope magnitude and direction (Fig. 9). The area sampled was not flat and sloped on both the X and Y axes (i.e. in two planes). A statistically significant relationship shown between heuweltjie height and erosion coefficient (Fig. 10) indicates a positive correlation between the two variables. Another positive correlation with statistical significance between heuweltjie volume and erosion coefficient is illustrated in Fig. 11. Slope and height are significantly positively correlated (regression: $r = 0.478$, $r^2 = 0.228$, $p = 0.004$), with slope as a predictor of height using the following equation:

$$\text{Height} = 1519.4 * \text{Slope} - 34.43$$

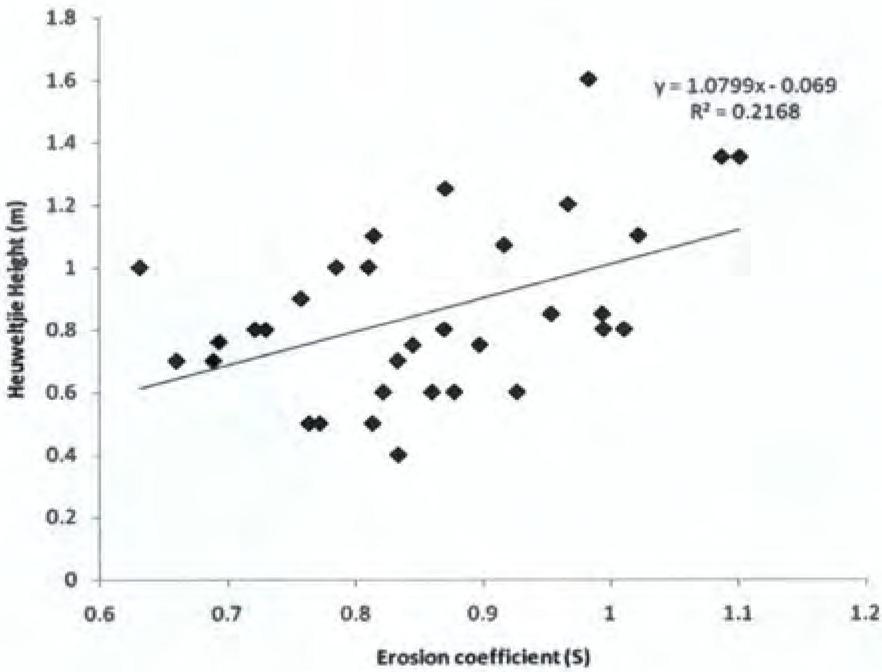


Figure 10. Correlation between heuweltjie height (m) and erosion coefficient (S). The relationship shown here was statistically significant.

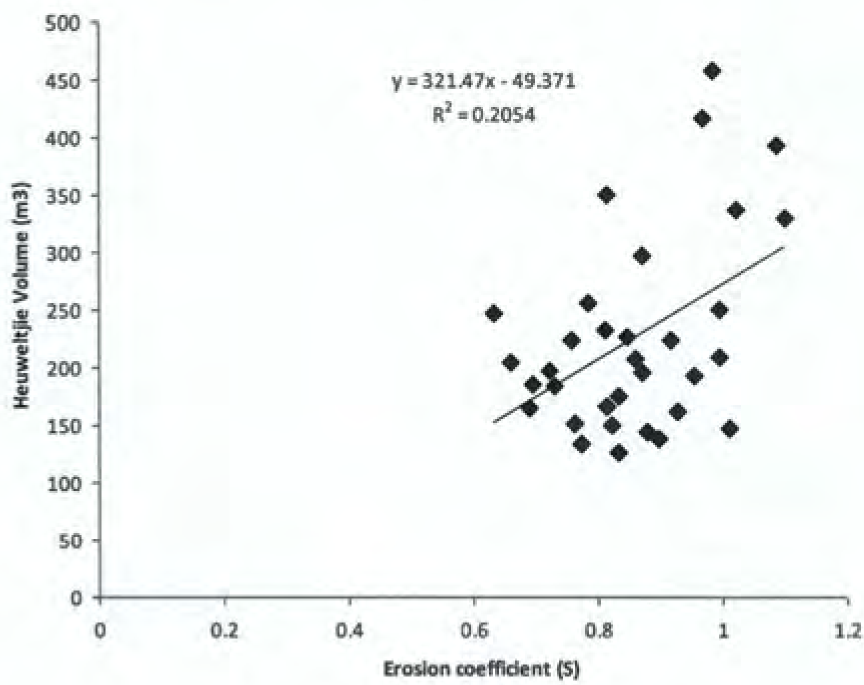


Figure 11. Correlation between heuweltjie volume (m^3) and erosion coefficient (S_i) showing a significant positive relationship.

Discussion

I hypothesised that I would find conclusive evidence to refute the termite hypothesis for the origin of the heuweltjies in Clanwilliam. Here I present several lines of evidence which, in my opinion, allows me to do that. Firstly the volumes of the heuweltjies provide an interesting point. Fleming and Loveridge (2003) report large *Macrotermes* mounds – reaching up to 6 m in height – to have a volume of just 27 m^3 of soil – a value a whole order of magnitude smaller than the average volume found for the heuweltjies of 234.7 m^3 (Table 1). Cox (1984) found Mima mounds at the Miramar Mounds National Landmark in San Diego, California to have a volume of up to 74.1 m^3), while Cox & Allen (1987) found the Mima mounds from the same area to have a volume of up to 85.2 m^3. Both heuweltjie height and volume correlate positively with the erosion coefficient S_i, indicating a possible erosional hypothesis for the formation of the heuweltjies. There is not enough evidence to make this assumption and more work needs to be done in this area in order to determine whether the mounds are erosional or depositional formations. The measured heuweltjies were found to have an eccentricity value of 1.1 (Table 1), indicating that they are almost circular in shape, although the down-slope axis shows significantly greater length than the cross-slope axis by an average of 4.9 %. No correlation was found between eccentricity and slope, although one may attribute a slightly longer down-slope axis to the effects of gravity and slump. Heights were variable, ranging from 0.4 to 1.7 m (Table 1, Figure 4) although we do see a positive correlation with slope, and though the relationship is not extremely strong, it still indicates an increase in heuweltjie height with an increase in slope.

My second line of evidence stems from the fact that termites are known to mine clay from below their own mound, aerating the soil and using the clay as mortar for mound building (McCarthy et al. 1998, Johnston 2002, Midgley 2010). Termite galleries can reach down to 10-15 m below the actual mound (Johnston 2002). The presence of bedrock beneath the heuweltjies in Clanwilliam casts doubt on the termite hypothesis in that it would be impossible for termites to build below ground galleries in bedrock. Thirdly, the fact that the soil profiles virtually do not change with depth in the heuweltjies as termites bringing the small particle fraction to the surface of the mound would cause the soil profile to indicate an increase in particle size with depth in the heuweltjies (Lee & Wood 1971, Moore & Picker 1991). Fourthly, the fact that we see no difference between the soil profiles of mounds and intermound areas implies that the same processes are occurring in both areas, making it unlikely that termites are affecting the mounds alone. That surface sand and silt are significantly different between on and off mound bears little significance in terms of termites in that termites mainly affect the clay and no differences in proportion of sand, silt and clay were found. In the trench (Fig. 8) we see a slight decrease in clay with proximity to the centre of the mound but only at 25 cm depth. At 50 cm there was no difference in % clay. One may argue that this indicates shallow termite activity, though the decrease in % clay was not significant, and the fact that this is only seen at 25 cm depth begs the question of how a 1 m mound has been formed, especially if below 25 cm we see no change in % clay.

Finally, soil mining also causes bioturbation i.e. downward migration of surface entities as the soil is removed from beneath them. In this manner one can explain the presence of rocks lying within the heuweltjie itself as they would previously have been at the surface (Johnson 1989, Johnston 2002). However, a rock of 25 kg on the surface of a heuweltjie is not so easily explained. The slope is not great enough (practically negligible) for the rock to have rolled downhill onto the mound, and the force of a flood would have to be great in order to transport rocks of this size. While floods can reach a magnitude at which they can transport very large boulders, a flood of that magnitude is unlikely in this area. I do not believe it would be possible for termites, while having been seen to transport stones to their mounds, to transport such large rocks to the tops of their mounds, and even if they could what would be the purpose?

Conclusions

The evidence presented supports my hypothesis and allows me to conclusively negate the termite hypothesis for the origin of the heuweltjies in Clanwilliam. Doubt is cast on the hypothesis by the two points expressed by Midgley et al. (2002) namely: a) while heuweltjie landscapes are found in conjunction with present and fossilised *M. viator* nests, *M. viator* nests occur in numerous landscapes where heuweltjies do not occur, for no known reason; and b) in landscapes with heuweltjie and termite interaction, both active and fossilised nests are found both within heweltjies as well as in intermound spaces. Here I provide evidence to support these doubts, in that the heuweltjies are underlain by bedrock and soil mining from beneath the mound is therefore impossible, as well as the fact that there are many rocks littering the surface of the landscape, some of which reach up to 25-50 kg, occurring both within and on top of heuweltjies. While termites may cause bioturbation and rocks within mounds may be explained in this manner, this cannot explain how a 50 kg rock came to be at the top of a mound. Soil profiles on and off mound indicate no difference in the processes occurring in the two areas and heuweltjie volumes were found to be a whole order of magnitude larger than even the larger *Macrotermes* mounds. No evidence was found to support a different hypothesis for the origins of the heuweltjies in this area and more work will need to be done before the question of origins can be definitively answered.

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